Effect of Seed Pelleting and Water Regime on the Performance of Some Forage Species

By

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DEDICATION

To my Father.

Karam Eldin Ahmeb Boush

To my mother.

Haleema Aldoma Abdallah

To my brothers and sisters.

To my great family

To my friends and colleagues

With endless thanks

Ashraf

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ABSTRACT

An experiment was conducted during the season 2008 in the Nursery of the Faculty of Agriculture, University of Khartoum, Shambat, Sudan, to investigate the effect of different levels of water regimes and three types of pelleting on growth and yield of Alfalfa *(Medicago sativa L.)*, Teff grass **(***Eragrostis tef***),** Rhodes grass **(***Choris gayana L***.)** and Siratro *(Macroptilium atropurpureum)*. Pelleting treatments used were farmyard manure, clay and silt in ratio of 1:3 and control using the gum Arabic as a cementing material. Three irrigation intervals were used namely every other day, every 4 days and every 6 days. The treatments were arranged in a completely randomized design with three replications. The results showed that plant height, number of leaves, number of plant per unit area, leaf area index and forage fresh and dry weights increased significantly with reduction of irrigation interval. Growth attribute and yield were higher in Teff grass and Rhodes grass than Alfalfa and Siratro. Pelleting techniques had no significant effects on yield growth parameters, except plant hight. However, generally the highest growth attributes seed pelleting treatments were recorded farmyard manure, followed by clay-silt mixture and lastly control.

ملخص الاطروحة

اجريت تجربة فى الموسم (2008) بالمشتل بكلية الزراعة – جامعة الخرطوم بشمبات لدراسة تاثيرمستويات مختلفة من المقننات المائية وثلاثة انواع من تغليف (تكوير) البذور على نمو وانتاجية البرسيم, حشيشة التف, حشيشة الرودس والسيراترو. معاملات تغليف البذور التى استخدمت هى روث الابقار وخليط الطين و الطمي بنسبة 1:3 والشاهد باستخدام الصمغ كمادة لاصقة .فترات الرى التى استخدمت هى الرى يوميا, كل اربعة ايام وكل ستة ايام. تم وضع المعاملات فى تصميم القطاعات الكاملة العشوائية بثلاث مكررات. اوضحت النتائج ان طول النبات وعدد الاوراق والكثافة النباتية ومساحة الورقة وانتاجية العلف الاخضر والجاف, زادت معنويا بتقليل فترات الرى. معايير النمو والانتاجية كانت اعلى لحشيشة التف وحشيشة الرودس من البرسيم والسراترو. تقنيات تغليف البذور لم يكن لها اثر معنوي علي معايير النمو والانتاجية الا بالنسبة لطول النبات لكن بصفة عامة فان اعلي معايير النمو لمعاملات تقنيات تغليف البذور كانت اعلى لروث الابقار يليه الطين مع الطمي وأخيراً الشاهد.

CHAPTER ONE

INTRODUCTION

The Sudan, the largest country in Africa, has an area totaling one million square miles. This area is broken down according to use into desert land (35.9%) pasture, forest and other grazable (61.3%) and cultivable and (2.8%).In brief about two –thirds of country is range and forest lands .This indicates the importance of rangelands in Sudan science forests are partially used for grazing (both understory and over story).

The type of vegetation in any area is largely determined by the prevailing climatic and edaphic condition. Sudan is characterized by having varying climatic condition that range from the desert in the north where rainfall is less than 75mm per annul. Rainfall increases southward until reaches about 1200mm in south western corner of Equatorial state. Temperatures and relative humidity are closely correlated with this variation in rainfall.

The type of vegetation in the Sudan as reported by Harrison and Jackson, (1958) starting from north to south included the following; desert, semi-desert, low rain fall woodland savannah –divided to low rainfall woodland savannah on clays, low rainfall woodland savannah on sands. Low rainfall savannah on special areas.

- High rainfall woodland savannah.
- Flood plain (Sudd Region) – Montane vegetation.

Each of the above divisions, except the desert, is broken down into several plant communities and association.

Rangeland is defined by the Society for Range Management (SRM, 1974) as the land on which the native vegetation (climax or natural potential) is predominantly grasses, lands revegetated naturally or artificially to provide a forage cover that is managed like native vegetation.

Rangelands include natural grasslands, savannah, shrub land, most deserts, tundra alpine, communities, costal marshes and wet meadows (Abu-Suwar, 2007).

One of the most important environmental issues facing Africa today is the threat of continued drought and desertification with their destruction of natural resources, agricultural land, and their political and social disturbances.

Desertification has been defined as the phenomenon of environmental degradation which terminates into desert like condition unfit for man and animal. Revegetation of range land with indigenous grass species has been attempted in many parts of Africa, Australia and United States of America …etc. Abu-Suwar, (2007).

Main advantages of revegetating rangeland include; sand dune fixation in degraded range land against wind erosion, improve range productivity and the development of livestock industry.

Different techniques and methods were developed with degraded to seed treatment against dormancy and for modifying the micro environment for faster germination and seedling establishment (Darag and Gad El- kareem, 1994).

The animal in the Sudan are greatly dependent on the natural vegetation as their sources of feed, for maintenance and production. This attitude is clearly reflected on poor output and performance of animals resulting from poor quality of forages and the problems of over grazing. Abu-Suwar, (2007).

The possible solution to support the natural pastures and is to establish and develop the irrigated pastures and encourage the utilization of agricultural by-products and residues that are produced in huge amounts for animals feeding in the Sudan.

The importance of vegetation cover either natural or cultivated in the peoples, socioeconomic political live is a very vital issue. Degradation of vegetation cover affects social, ecological aspects. Lack of vegetation cover due to irregular rainfall, mismanagement of natural resources and changing the use types without being aware of the fragile properties, accelerate the degradation of the vegetation cover and increase the poverty condition of local communities living in these areas. Improper use of vegetation cover has resulted in severe environmental problems, including increased desertification degradation. Degradation of vegetation is now resulted in severe environmental problems including desertification, global warming, climate change and biodiversity.

Reversing the process of land degradation in these environments poses challenges. Innovative, participatory community-based approaches and sound practices are needed to better manage the natural resources, especially the limited water resources and vegetative cover.

- The purpose of this study is to conduct field trials to develop pelleting seeds suitable for revegetating deteriorated arid rangelands.
- Different grass seeds species will be subjected to different treatments for testing their viability with and without pelleting.
- Nature of seeds emergency and development.
- To test the effect different levels of irrigations on different rangeland grasses.

CHAPTER TWO

LITERATURE REVIEW

2.1 Seed pelleting and pellet improvements:

A working definition for seed pelleting is as follows: materials are added to change seed size and shape for improved plant ability. Small and irregularly shaped seed can now be treated as larger, round-shaped seed. Singulation of seed in the field is therefore easier. There are two components to a seed pellet:

Bulking (or coating) material and binder. The bulking material can be either a mixture of several different mineral and/or organic substances or a single component. The coating material is the "work-horse" of the duet. The coating material changes the size, shape and weight of the seed. Desirable characteristics of a good coating material include: uniformity of particle size distribution, availability of material, and lack of phytotoxicity. The second component, the binder, holds the coating material together. Binder concentration is critical because too much binder will delay germination. Too little binder will cause chipping and cracking of pellets in the planter box, which can cause skips and/or wide gaps in the plant rows. Many different compounds have been used as binders, including various starches, sugars, gum Arabic, clay, cellulose, vinyl polymers (Halter, 1987) and even water (Burgesser, 1949).

Historically, the increased usage of pelleted seed occurred with the outlawing of the short-handled hoe in California in the early 1970s. This legislative change caused an increased demand for pellets because only with pelleting could lettuce seed be adequately field-singulated for thinning with a long-handled hoe. Several other methods of preciseling planting lettuce seeds have become commercially available over the years. Products like the seed tape (Gurley, 1970) and seed tablets (Robinson and Johnson, 1970); Sharples and Gentry, 1980) have been commercially available and tested on a large scale. However, the vegetable industry has retained seed pelleting as its preferred precision planting.

2.2 The use of pelleted seeds for range rehabilitation:

Laboratories as well as field trials were carried out by (Darag and Gad Kareem, 1994) from western Sudan Agricultural Research Project, to develop seed pellets for revegetation of degraded rangeland particularly in sand soils. The implementation of seeding using pelleted seeds was executed during 1997 and up to 1999 within the Community-based Rangeland Rehabilitation Project for Carbon Sequestration and Biodiversity in Bara of Northern Kordufan State.

In this trial nine seed species were tested namely the following:

Panicum turgidum

Pennesetum spp

Aristida funiculate

Cenchrus ciliaris

Aristida mutabilis

Cenchrus biflorus

Cenchrus setigerus

Chloris vegata

The main objective of this experiment was to select the best technique to be used for seed treatment against dormancy. Then to chose the best mixture of earth pellet that could be applied to speed up the rate of germination so as to make sound proposal for sand soil dune fixation through the rehabilitation of range vegetation cover within the project area.

-According to the trial indicated that pelleted seeds with clay: silt (3:1) with the addition of organic manure and 1% of KNO3 improved rate of germination of grass seeds tested. Seed treatment with cold water before pelleting for 24 hours proved to increase percentage germination of *Pannicum turgidum* to 80% and *Cenhrus biflorus* to 24%.

The highest percentage germination of pelleted seeds was scored by *Chloris gayana* (95%) and *Pannicum turgidum* (80%).These species were recommended to be used for the revegetation of the degraded land around Bara of north Kordofan State.

2.3 Arid and semi-arid zones rangelands:

The extensive rangelands of the arid and semi-arid zones of developing countries and the people they support are in varying degrees of crisis as a result of rangeland degradation, brought about by overstocking. The area is traditionally used solely by pastoralists under nomadic and transhumant systems, but the pressure of human population has led to the incursion of agriculturalists with their livestock into marginal areas, so putting an unbearable pressure on the rangeland vegetation.

Much has been written about the current state of rangeland vegetation, the social and economic impediments as well as the technical difficulties in reversing the deterioration (e.g. UNESCO, 1979; Jahnke, 1982; Harrington, 1982 and Malechek, 1982). While there are cases or instances of potential improvements or improvements actually made, the consensus of opinion of authors is that the only solution short and midterm is to reduce grazing pressure. It is recommended that this be achieved by destocking, or by deferred grazing or some other form of grazing management which would permit a more even grazing and reduce severe overgrazing on critical areas. A recent FAO review

(FAO, 1984) commented that there is need for rehabilitation by the introduction of good management, that forage cultivation is not yet generally accepted and conservation of hay and silage rarely practiced. There is a need to introduce forage trees and browse shrubs, but there was little likelihood of increasing forage availability in the near future due to pressure of livestock combined with the persistence of drought.

The productivity of the arid and semi-arid zone rangelands is low. Jahnke, (1982), was quoting other authorities, gives a figure of 2.5kg DM/ha/annul per mm rainfall, or it DM/ha/annul at 400 mm which is likely to be inefficiently utilized. Such yields cannot hope to generate enough income to provide incentive to introduce improved species even if this were technologically feasible. While acceptance by the inhabitants and by Governments that reduction in grazing pressure is the only short term solution, one must not be entirely negative. Observation and development project results indicate that there are avenues for improvement and some specific examples of these are listed below.

- Grain yields and sheep production were twice as great in South Australia through replacing fallow with subterranean clover and medic pasture, compared with Algeria having a similar Mediterranean climate but not integrating crop and sheep grazing (Allden, 1982).

- In the Drought Prone Areas Programme in Western India the introduction of *Cenchrus ciliaris* and *Lasiurus sindicus* increased DM yield from 0.4 to 3 t/ha/annul (Jain, 1983).

- Depleted rangeland in China has been shown to be capable of yielding 3t DM/ha/annum by over sowing with milk vetch and fertilizer. In another site having 300 mm rainfall, all in summer, the yields of native grassland have been doubled with fertilizer alone, while in cultivated areas the use of newer cultivars of sorghums, maize, and annual grasses for silage, and native grass for hay has also doubled the number of stock carried as well as improving them greatly (FAO, 1983).

- The Syrian Arab Republic Rangeland Conservation and Development Project is one of the best known, reviving the ancient “Hema” system of grazing control, introducing *Atriplex spp*. planting fodder trees and creating lamb fattening cooperatives Draz, (1978).

- The wide ranging development project in Morocco where *Agropyron elongatum* has been introduced into a *Stipa-Artemisia* ecosystem in a 300 mm rainfall area (El Gharbaoui, 1984).

- The introduction of *Atriplex* and *Kochia spp* in Saudia Arabia (Hassan, 1984).

- The legumes *Stylosanthes humilis* and to a lesser degree *S. guyanensis* have been shown to be capable of being over sown or direct drilled on sites in the semi-arid zone.

There are also arid or semi-arid rangelands in the temperate zone (U.S.A., South America, South Africa, and Australia) which have also degenerated under overstocking during the last 100 years and it is significant that in all of these stock numbers have declined. The most intensively studied are those in the U.S.A. and in a recent review of rangeland management and reseeding results, it is commented that “a considerable portion of western rangelands currently support vegetation assemblages greatly below their potential" (Herbel, 1984; Young *et al* (1984). Wilson, A.D. (1982) in another review concludes that "there are no technological improvements in the pipeline that will lead to major productivity gains. The basic restrictions of sparse vegetation, low rainfall and a harsh climate are not subject to technological innovation". Nevertheless there are instances that in all of these countries improvements are technically possible. To take but one example, (Stevens and Villalta, 1983) at high altitudes in Peru were able to establish ryegrass-clover pastures and to direct-seed Lucerne into rangeland with large increases in sheep numbers carried.

The problem is that research and development projects in both developed and developing countries on which the possibilities if improvements have been shown have high inputs of technical and economic aid. Whether they can survive in a straight commercial sense and whether it is economic to attempt to increase production is highly dubious. In the more favourable sites it may be so, but for most of it, the problem is to halt further deterioration. The poor income-generating power of the extensive rangelands dictates that any improvements must be ecologically sound and low cost, and should act in a catalytic role to permit better utilization of the much larger area of unimproved land.

Research priorities suggested should include grazing management studies to provide more even grazing pressure, forage conservation, selection of species and cultivars extending growth into the dry period, integration with cropping systems. (UNESCO, 1979; Malechek, 1982; Butterworth *et.al*, 1984).

2.4 Ranching and Mixed Farming System:

Crop production is an occupation of agriculturalists living in villages mostly in the semi-arid and sub humid zones. Traditionally some nomads have included the grazing of crop stubbles in their annual movement, while transhumant pastoralists have also made use of stubbles and crop residues during the dry period. The increasing sedentarisation or semi-sedentarisation of nomads and transhumant's, together with movement of agriculturalists with their own livestock in the opposite direction into drier areas is reducing the areas available for grazing and also increasing the risks of crop failure. The integration of cropping with sheep and goats is primarily in the semi-arid zone but extends into the sub humid zone. Although the cropping regime yields more DM/ha in the form of stubbles, straws and byproducts available for stock the increases in stock numbers more than offsets this. Nevertheless cropping systems and the more intensive and settled human existence in villages or permanent abodes, offers an environment much more amenable to technological change and improvement than does the rangeland. The following research developments in recent years are some of the more promising.

- The breeding of improved cultivars of human feed crops - wheat, maize, sorghum, groundnuts etc. and research on fertilizer responses, together with an appreciation that in subsistence agriculture, fertilizer put on crops increases yield sufficiently to release land for planting in animal forage crops.

- Research and demonstration has shown that forage production can be expanded considerably by inter-row sowing of legumes with the cereal, using improved cultivars of forage species, and especially replacing the traditional fallow with sown perennial or annual forage crops. Legumes such as

Stylosanthes and vetches, and other tropical legumes in higher rainfall areas, are much preferred since their nitrogen level and nutritive value are high and they increase soil nitrogen for the next cereal crop. High yields have been obtained in Cyprus from barley and barley/vetch forage made into hay (Osman and Nersoyan, 1984; UNESCO, 1979; FAO, 1983). If a move to greater use of forage crops and more efficient use of grazing stubbles is to be made then control of the sheep and goats becomes important. Attempts should therefore be made to gain acceptance of the electric fence by herders and cultivators.

- Intensive fattening of lambs and kids, on locally grown roughage plus concentrates and by products, has a double advantage of controlled marketing with a superior product and more importantly of removing young animals to be fattened from the overgrazed rangeland, thereby reducing the grazing pressure. Lamb fattening trials have been reported from several countries showing typically that weaned lambs make gains of 100 – 250 g/day with feed conversion ratios of 6 to 10 according to the energy content of the diet. There is a need to examine what effect this has on the total system.

- Some arid and semi-arid areas have water available for irrigation, which is used mainly for cereal or cash crops (cotton) but some is available for forage. Water from the Nile is used in Egypt and Sudan, underground water in Libya and Saudi Arabia. Extremely high yields of Lucerne (*Medicago sativa*) and Egyptian clover (*Trifolium alexandrinum*) are obtained and provide a high protein source for cattle, sheep and goats.

- Improving the utilization of low quality roughages is also possible. Low protein levels characteristic of tropical forages during the long dry period are a limiting factor in animal intake and performance. (Minson, 1982). A considerable amount of research work has been done over the last 20 – 25 years on the use of urea to improve the voluntary intake of straws and other low quality roughages by cattle, sheep and goats. Trials conducted in pens have almost universally given good results but selective grazing by animals in the field has caused some doubts about its application in a grazing context (Coombe, 1981). A more recent discovery is that alkali or ammonia treatment of straw can increase digestibility by 10–15units, e.g. from 45% to 55–60%. Encouraging results are being obtained from the technique at both the village level (Dolberg *et.al*, 1981), and the factory level (Creek *et.al*, 1984).

A much better understanding of protein requirements of sheep and goats has been developed during the last decade, with recognition of the significance of rumen no degradable protein.

This is of special importance in the tropics (Lindsay, 1984).The outlook then for improvements in pastures and crop production, and of utilization by sheep and goats in the cropping areas is reasonably encouraging. Whether it can keep pace with the increases in human population is another matter. Fortunately much of the research done in developed countries is less sensitive to environment in a cropping activity than in a grazing activity, and is therefore more likely to find application in the cropping scene. The most important fields of research in the cropping areas as far as sheep and goats are concerned are likely to be further integration of pastoralism with cropping, conservation and forage production for the dry period, and improvements in the utilization of straws.

Somewhat similar problems exist in the semi-arid/cold regions of the world such as in the arc from Turkey to China and Russa. Here the winter replaces the dry period of the tropics. In the Northern China for example, many pastoralists have been semi-or wholly sedenterised, and winter bases exist in villages or have been especially constructed. The growing of forage, partly for grazing but mostly for conservation as hay and silage, is a dominant feature of the system (Demiruren, 1982).

2.5 Tropical Pasture Development:

Present native pastures consisting of *Hyperrhenia, Andropogon, Themeda* and many other species exist in a savanna landscape derived from forest or woodland. Soils are heavily leached, grazing is primarily with cattle and fire plays an important part in the grass, scrub, tree balance. The most important development in this area in the last few decades has undoubtedly been the selection, breeding and cultivation of improved cultivars of tropical grasses and legumes. The legume is particularly important because of the low nitrogen status of tropical soils. Though this work has been carried out in several tropical environments the driving force has been the CSIRO Division of Tropical Pastures in Queensland, Australia (Mannetje, 1982; Minson, 1982). Now there are established cattle ranches and cattle projects in most tropical countries with rainfall in excess of 800–1000 mm.

Unfortunately, in relation to sheep and goats, the basic grazing experiments and present projects are almost wholly involved with cattle. There are good reasons for this cattle dominance, but not for the exclusion of small ruminants. Very high yields of pasture DM are attainable - up to 30 – 40t/ha/annul but control of pasture growth, maintenance of the grass-legume balance, and ingress of weeds do present greater problems than with temperate pastures (Mannetje, 1982). Nevertheless the potential of these tropical pasture species for small ruminants with or without cattle should be explored. Some trials using sheep and goats have been recorded (Boulton and Norton, 1982; Potts and Humphreys, 1983; Susetyo *et al*, 1983) but not yet on a farm scale. Some of the improved species, especially legumes such as *Stylosanthes humilis* and *S. guyanensis*, *Macroptilium*, *Desmodium spp* are also finding use as forages for establishment on fallows which are grazed by sheep and goats in both semi- and sub humid zones.

2.6 Alfalfa *(Medicago sativa* ***L.)*:**

According to Agabawi, (1968) the crop was first introduced into the Sudan during World War 1 when seeds of the variety 'Higazi' was imported from Egypt for cultivation in north of Khartoum. This variety was compared by Agabwi, (1968) with three introduced American varieties and reported that it consistently outyielded them in forage production. Pioneer 572 were introduced to the Sudan by the Pioneer Company (Salih, 1987).

2.6.1 Seed production:

Growing alfalfa for seed production in the Near East has usually been of secondary importance to the forage production. Furthermore, some areas that successfully grow alfalfa for forage are unfavorable for consistent seed production. Great differences in environmental conditions, such as soil texture, soil depth, rainfall, strong winds and seasonal temperature variations indicate the need for several production systems for any individual country, each system tailored for specific conditions (Marble, 1970).

2.6.2 Growth:

Seedling emergence usually occurs within four days, but the soil should be kept moist for at least the first ten days. On heavy clay soils crusting can prevent the emergence of alfalfa seedling (Mackenzie and Bolton, 1947). Moreover, moisture supply should be adequate and drainage should be good to avoid water logging. Also insufficient water reduces growth, shows abnormally dark green leaves, and in extreme cases wilting occurs (Marble, 1972). Compared with other crops alfalfa has a high water requirement, because of its rapid growth, length of growing season and the large amount, of green matter produced produced each season (Erie , 1966).

Near the surface of the ground the stem branched thick stem branches profusely and with age becomes woody producing a crown of short , highly branched thick stems from the buds of which the aerial shoots are produced (Leslie, 1963).

Ahlgren, (1956) stated that the alfalfa plant passes through a cycle of storage and depletion of root reserves when the tops are removed, stored food in the fleshy roots is utilized to renew top growth. As enough top growth develops, the photosynthetic activity increases to a point where surplus energy is produced, and this is sent to the roots, accumulating as starch. Each time the crop is mowed or pastured this cycle of depletion of root reserves and their subsequent renewal is repeated. Cutting at 50% bud stage or 10% flower does not allow sufficient time for roots to stand by the summer of each year (Hageman and Marble, 1983; Massengale, 1974).

Al-Noaim and Farnworth, (1973) showed that Hassawi alfalfa regrowth was dependent on root and crown reserves. They reported that cutting frequently did not allow accumulation of these reserves. It seems that Hassawi alfalfa behaves in a similar manner to varieties of alfalfa in other area of the world, giving higher yields and more vigorous stand if cutting is delayed to a relatively mature stage. The best time for flowering varies from one region to another. Timing the flowering during late May and June led to the highest seed yields (Abu-Shakra *et al,* 1977). Khartoum University Farm records showed that during and after the rainy season (July – November) the yields of alfalfa were reduced by about 30 – 50%. The reason for the decline was attributed to a complex relationship of weed competition, temperature, humidity and rainfall. During this period the weed infestation is at its maximum and in many cases the crop may be completely smothered. At the same time the effect of increased temperature and high relative humidity seems to retard the growth (Osman, 1971).

2.6.3 Weather:

Ahgren (1956) stated that a dry atmosphere with little or on rainfall together with warm, bright days and cool nights favor flowering, pollination and seed setting. Extremes in temperature especially during blooming and pollination will injure the flowering, limit pollination and reduce seed set. Similar results were obtained by Weeler and Hill (1957).

Dry weather is essential for alfalfa seed production during maturity and especially at harvest (Pedersen *et al.* , 1972).High alfalfa seed yields (800kg/ha) were obtained under warm climate, sunny days and long dry growing season in which wild insect pollinators were available. Hollwell (1962) indicated that insect pests of a seed crop can be controlled more effectively in dry than wet weather as the insecticides are effective for longer periods. Moreover, plant diseases are, also generally less severe in dry and hot regions.

2.6.4 Soil:

Bolton (1962) reported that mature alfalfa grows well in moderately saline conditions but the seeding is known to be more susceptible to salinity.

With respect to the application of fertilizers, Pedersen *et al*, (1961) reported that alfalfa did not have, in any cases, any response to nitrogenous fertilizers, as alfalfa has the capacity to obtain N form the air through N-fixation, in its root nodules by the bacteria of the genus Rhizobium. The physiological conditions that are favorable for nitrogen fixation vary greatly for different species and strains. Lupian bacteria are the most acid-tolerant, and those of alfalfa the most sensitive. Thus a neutral or slightly alkaline reaction is preferable for alfalfa, and liming is necessary in highly acid soils.

It has been shown that alfalfa strains have an optimum temperature between 15˚C and 30˚C, and sharp drops in activity at ranges from 10˚ to 12˚C and from 35˚ to 40˚C. If alfalfa plants are placed in permanent darkness, the bacteria cease fixation and become parasitic. Fixation is optimum with moderately rapid photosynthesis and is depressed at excessive rates of photosynthesis. Various minerals have important effects in these connection, like molybdenum, phosphorous, potassium, calcium and boron .Nodules vary in size, shape and their ability to fix nitrogen according to the plant on which they occur in (Hughes, *et al*, 1962).

Bolle-Jone (undated) of the FAO concluded that alfalfa required phosphate regularly, and a small amount of starter nitrogen at seeding only and there was no benefit from potash. Both phosphorous application and Rhizobium inoculation of seeds significantly increased plant height, shoot fresh and dry weights, and root fresh and dry weights and improved nodulation of Hegazi and Pioneer cultivars, both at 8 and 10 weeks of age.(Abusuwar and Mohamed, 1997).

They also found that phosphorous application increased plant density, seed yield component and final seed yield in the two cultivars.

2.6.5 Irrigation:

Abu-Shakra *et al*, (1977) stated that irrigation applied once every two weeks, produced the greatest seed yield as well as an increase in the number of pods per raceme, number of seeds per pod, and 1000 seed weight. Plants irrigated at three or four week intervals produced the highest number of seed weight. Plants irrigated at three or four week intervals produced the highest number of seeds .Pedersen *et al*, (1972) reached similar finding.

Tysdal, (1946) stated that his observations indicated that normal and medium vegetative growth produces maximum seed yields. He also indicated that seed yields declined as the soil moisture content increased and the decline was proportional to the stand density. He reported that when alfalfa was grown in pots seed yields increased with increase soil moisture. Cohen et al. (1972) concluded that timing of irrigation that leads to an increase in the food reserves during the period of initial regrowth is likely to increase the seed yield potential of alfalfa.

2.6.6 Insect Pests:

The importances of the control of harmful insects in alfalfa seed production cannot remphasized. Harmful insects can be effectively controlled with insecticides (Pedersen *et al*, 1955). High yields of alfalfa seed can be obtained only if certain key insect pests are kept at minimum populations. These may vary with regions. Utilizing proper cultural practices will minimize the need for insecticides during flowering (Bacon, 1980; Bolton, 1962; Marble, 1980 Pedersen *et al*, 1955).There are, however, many insects that are peculiar to alfalfa seed production as damage is concerned. Only a very small amount of information exists on harmful insects in seed fields in the countries of the Near Est. It is absolutely necessary for effective destructive insect control to monitor seed fields before alfalfa plants are in bloom, to discover the insects that can destroy young flower buds before there are even visible (Marble, 1984). After bloom the greatest threat is from flower and seed-feeding insects that destroy flower buds, flowers, and young tender, immature seed through the first 15 days after pollination or until seeds are hard. Bacon (1980) and Atkins (1983) reported that an integrated pest management (IPM) program is essential for alfalfa seed production.

2.7 Siratro: *(Macroptilium atropurpureum)*:

There are about 200 species of Siratro. They are mostly erect or twining herbs, native of China, India, Central and South Africa. Numerous cultivated

beans provide human food and are all grazed by livestock. Siratro a perennial bred by Hutton of CSIRO from two Mexican forms of M. atropurpureum in the early 1960's.It is the outstanding achievement for breeders of pasture plant in Australia. It spreads by creeping stems. It has three lobed leaves, it does well in hot tropical summer, but like all tropical pasture legumes will not tolerate frost.
Siratro is adapted to a wide rang of soils with respect to texture and pH. It does particulary well on many sand soils and can succeed on quite shallow soils. It grows in areas with annual rainfall ranges between 600-1800mm. Siratro recover quicky, form drought by seed germination and new growth of an old stems. Planting seed rate: ranging between 2 to 4kg/ha. It nodulates freely and effectively with wide strains of cow pea rhizobium.Seed production may attain 100-160k/ha. Average crude protein content about 23% and crude fiber about 30.4% (Skerman *et al*, 1988).

2.7.1 Soil requirements:

Siratro occurs on awide range of soils ranging from dark cracking clays, to yellow and red clays, to red sands and gravels. Soil reaction at collection sites ranges from pH (5.5-) 6.5-8.0 (-8.5). In cultivation, 'Siratro' has been successfully established in soils with pH 5.5- (and even as low was 4.5), and in coral rubble (pH 8.5). It thrives in friable soils, but decline fairly rapidly in hard-setting soils .Tolerant of moderate levels of soil Al and Mn, and better tolerance of salinity than most tropical forage legumes. While preferring well-drained soils of moderate fertility, some collections have been made at poorly drained sites and on infertile soils.

2.7.2 Moisture:

Siratro is well adapted to drought, possessing a deep taproot and the ability to minimize evapo-transpiration by virtue of pubescent leaves, and reduction in leaf size and shedding of leaves in response to the onset of dry conditions. It is intolerant of flooding or water logging.

2.7.3 Reproductive development:

Flowering is initiated in response to onset of dry periods and to shortening days. Vegetative growth resumes with the retum of moist condition. Pods shatter when mature and seeds can rot in pods under wet conditions during seeding.

2.7.4 Ability to spread:

Siratro is mostly spread by seed, since stolon development is typically very weak. Seed is forcibly ejected from the pod and can be thrown for several meters. It can be spread great distances through water movement and following ingestion by cattle.

2.7.5 Palatability/acceptability:

Siratro is readily accepted although cattle prefer fresh young grass early in the growing season. Siratro is heavily browsed by deer, and quail are attracted to the seed crop.

2.7.6 Seed production:

Seed can be either hand or machine harvested. For hand harvesting, ripe pods should be picked early with little stimulation. For larger scale commercial production, growth flushes are produced through irrigation with flowering occurring as moisture declines. Crops are then fairly synchronous, and can be direct-headed when the majority of pods are ready to shatter. Fallen seeds can then be collected with a suction harvester. Seed yields vary greatly from (40-) 100-300 (1,000) kg/ha.

2.7.7 Season of growth:

Summer-growing perennial with greatest growth in midsummer to autumn in south-east Queensland.

2.7.8 Rainfall requirements:

Siratro requires at least 615 mm and preferably more than 850 mm. It does not thrive in high rainfall regions above 1800 mm.

2.7.9 Tolerance to flooding:

Siratro is extremely drought-tolerant by reason of its deep-rooting. In summer droughts, large leaves are shed and small leathery leaves produced until condition are more favorable (Davies and Hutton, 1970).It is not tolerant of flooding.

2.7.10 Seed treatment before planting:

To break down dormancy: (a) scarify mechanically; (b) treat with concentrated sulphuric acid (sp. gr. 1.8) for 25 minutes wash and dry (prodonoff, 1968).Inoculation is not necessary but preferable. Pelleting is not necessary unless to protect rhizobia, pellet with rock phosphate (Norris, 1967) and (Jones, 1965).

2.7.11 Seed harvesting:

Siratro does not seed prolifically in districts where it thrives as pasture. Therefore, although pastures may be harvested for seed, it is better in the long term to seek specific seed producing districts. These should have a very dry and frost-free winter. From one to four crops may be produced each dry season, depending on temperature and rainfall patterns and irrigation use. Use of insecticide over the flowering period is necessary for heavy yields. Each crop may be harvested as it ripens (if hand harvesting or using a small header); or a single end-of-season header harvest may be taken, followed by suction harvesting. The latter system produces very high yields with minimum labour input, but requires sophisticated management and machinery.

2.7.12 Pests:

Colbran, (1963) found that siratro was attacked by the root nematode *Helicotylenchus dihysteram* but was resistant to *Meloidogyne javanica* and *Radopholus similes*. Therefore, recommended it (Colbran, 1964) in conjunction with green panic as a suitable cover crop for control of nematodes in banana plantations. The bean fly (*Melanagromyza phaseoli*) will attack seedlings up to three to four weeks of age, but it can be prevented by seed treatment (Jones, 1965). Meloid beetles, which may prevent flowering in the tropics. The plant is resistant to the Amnemus weevil. In Florida, the bean leaf roller (*Urbanus proteus*) attacks siratro in late summer and autumn (Kretschmer, 1966).

2.8 Teff grass: (*Eragrostis tef*):

Eragrostis tef (Zucc.) Trotter, Poaceae, commonly referred to as tef (also t'ef and teff), is an annual C-4 grass (Kebede *et al*, 1989) native to Ethiopia which is grown in Australia, India, and South Africa as forage (Costanza *et al*, 1979). Tef flour is used by Ethiopians to make an unleavened sourdough bread called "injera." Tef seed has a good balance of essential amino acids, except lysine (Ebba, 1969). The great diversity within the species is evident in seed color differences; there are reports of purple, white, brown, and red-seeded types (Mengesha 1966; Costanza *et al*, 1979). The diversity also enables teff to be grown in a variety of environment.

2.8.1 Description:

An annual forming scanty tufts; culms up to 120 cm high in selected cultivated plants, but often only 20 cm when growing as a weed, glabrous. Leaf-blades narrow, folded. Panicle narrow, 18-20 cm long with a depressed branches at the base; spikelet grey or golden, 8 mm long with up to ten florets and rather large seeds (Napper, 1965). In Ethiopia two types are grown, one with white seeds (preferred) and one with brown seeds.

2.8.2 Distribution:

Native of Ethiopia introduced into other tropical countries.

2.8.3 Season of growth: Summer.

2.8.4 Altitude range: Sea-level to 1800 m in Kenya. In Ethiopia, 1800-2400 m, at which height white Teff disappears. Above 2400 m brown Teff is grown.

2.8.5 Rainfall requirements: In Ethiopia, it grows on an average rainfall of 500 mm. The maximum rainfall is 2 500 mm.

2.8.6 Soil requirements:

Mainly sandy loams, but can grow on black soils (Westphal, 1975). A surface crust will kill off delicate young plants.

2.8.7 Land preparation for establishment: A very fine seed-bed is needed.

2.8.8 Sowing methods: It can be planted, broadcast or sown in rows and weeded.

2.8.9 Sowing depth and cover:

Sown on the surface or no deeper than one cm (Bogdan, 1964). Cover by rolling or driving sheep across the area.

2.8.10 Sowing time and rate: July or August in Ethiopia at 15-20 kg/ha, or up to 40 kg/ha as a cover crop for moisture conservation in Kenya.

2.8.11 Number of seeds per kg: 2.5-3 million.

2.8.12 Seedling vigor: The seedlings are small and delicate and should be carefully weeded. The crop may need thinning.

2.8.13 Vigor of growth and growth rhythm: It matures in ten to 12 weeks.

2.8.14 Suitability for hay and silage: It is widely grown for hay in Transvaal and Orange Free State and in the United States. It is one of the faster growing hay crops known.

2.8.15 Seed yield: 270-800 kg/ha.

2.8.16 Cultivars:

No cultivars have been released, but there are wide ecotypic differences both in morphology and agronomic response. Very productive types can be selected.

2.8.17 Diseases: Rust, *Uromyces eragrostides*, sometimes attacks it.

2.8.18 Main attributes: Highly adapted to marginal rainfall areas and valuable for range reseeding.

2.8.19 Optimum temperature for growth: Maximum temperature is 25-28°C.

2.8.20 Frost tolerance: It is susceptible to frost.

2.8.21 Palatability: Very well grazed. The seed is eaten by wildlife and cattle, contributing significantly to their diet at certain times of the year.

2.8.22 Tolerance to flooding: It can tolerate water logging.

2.8.23 Fertilizer requirements: It is usually fertilized with farmyard manure in Ethiopia and is used in a rotation containing beans as a leguminous crop.

2.8.24 Genetics and reproduction: 2n= 40 (Fedorov, 1974). An apomict.

2.8.25 Seed production and harvesting: It is a good producer of seed, which shatters easily. The heads are cut with a sickle when the panicles become grayish, cured in heaps in the field and then threshed by flailing or trampling with oxen.

2.8.26 Economics:

In Ethiopia the grain is used as human food, accounting for more than half the country's grain production. In east Welega (Ethiopia), crops of Teff, barley and sorghum are sown in June and July and harvested in December. After harvest, the farmers enclose a plot of land to be used for next season and cattle use the pasture for ten to 15 nights to manure the field and are then moved to another area the "shifting stable" system. Usually one year of teff is followed by beans, then barley and sorghum. In the Yerer-Kereyu Highlands of Shoa, east of Addis Ababa, teff is planted in well-prepared black cracking clays.

2.8.27 Chicken manure:

The nutrient composition of poultry manures vary with type of birds, the feed ration, the proportion of litter to droppings, the manure handing system, and the type of litter.

Poultry manure varies not only with its nutrient composition availability, but also with management and handling cost. Except for nitrogen, the availability of most nutrients in poultry manure is fairly consistent, Nitrogen can occur in several forms, each of which can be lost when subjected to different management, or environmental conditions.Gamar (1984).

2.9 Rhodes (*Choris gayana* L.):

Rhodes grass is a C.4 species widely used as forage in tropical and subtropical areas and known for it is ability to withstand dry condition, soil salinity, and light frost. It belongs to the family Poaceae and sub tribe chloridoideae. (Luna *et al*, 2002). As a tropical grass with the C4 type of photosynthesis, like corn and sugarcane, Rhodes grass efficiently uses solar radiation and the available soil moisture to quickly accumulate relatively high amount of biomass. (Valenzuela and Smith, 2002).

2.9.1 Benefits provided by Rhodes grass:

Valenzuela and Smith, (2002) described the benefits and uses of Rhodes grass as excellent for erosion control and weed suppression, well for quick growth, although establishment maybe relatively slow. Tolerates drought and saline conditions, but not shade. Fair forage production, nutritional quality and palatability. Use in plantation and orchard cropping systems such as macadamia, coffee, and papaya, and as "living sod" in vegetable production.

2.9.2 Environmental requirements:

2.9.2.1 Temperature and Photoperiod:

According to FAO (2003) the optimum temperature for growth is 30/26 C to 40/29 C day/night temperatures, and minimum temperature is 8˚C. Response of Rhodes grass to photoperiod recoded by Skerman and Riveros, (1990) for optimum day lengths are ten to 13 hours.

2.9.2.2 Soils:

Rhodes grass is grown on wide ranges of soils, from clays to sand loams. It does not do well on very heavy clays, but it grows well on loose textured soils such those derived from volcanic ash. (Valenzuela and Smith, 2002).

Mclove *et al*, (1982) showed that *Chloris gayana* was adapted to slight soil but it was the outstanding grass at that site. Harwood *et al*, (1999) reported that

Chloris gayana had poor emergence (4-5.5%) on moderate-very strongly alkaline/medium- high salinity class tertiary spoil soils.

Rhodes grass is quite versatile in its soil requirements, although it grows best on softwood scrub red loams and strong brigalw soils. (Partidge, 2003).FAO, (2003) reported that the crop grows on a wide range of soils, but may have some establishment problems on acid soils. Ortega *et al*, (2006) pointed that salinity have harmful effect on growth of *Rhodes grass* seedling Leaves and elongation on successive days. This is due to reduced hydraulic conductance in salt-stressed plants.

2.9.3 Rhodes grass as forage:

Chloris gayana can be used as fresh forage or in the form of silage, but utilization as hay and green forage is the major use. According to (FAO, 2003) the crop makes good quality hay if cut just as it begins to flowering or a little earlier. Old stand give low quality hay. Silage has been made successfully in Nigeria, Zambia and Northern Australia, but generally it does not give satisfaction silage. Rhodes grass is widely grown on rangeland, irrigated agriculture.

In Zambia *Rhodes grass* alone yielded 58 DM ton/ha. Under irrigation in Texas, yield of dry matter is 15.8 ton/ha was recorded. In South-West Australia a yield of 23.6 ton/ha was obtained from an irrigated Rhodes grass pasture treated with three dressings of fertilizer at eight week during the summer (November to April), each dressing providing 56, 22, 45 kg/ha of Nitrogen, Phosphorus and Potassium, respectively, (FAO, 2003). Duke, (1983) found that the dry matter yield was 15.5 MT/ha annually in Florida, U.S.A, and higher yields reported when planted in 25 cm rows and fertilized with 150 kg N/ha.

Gherbin *et al*, (2007) showed that *Chloris gayana* yielded high dry matter in warm-season areas when grown with other butter fly pea and phillipesara in

Sudan . Ehlich *et al*, (2003) pointed that reducing the frequency and total volume of irrigation resulted in a reduced level of soil water and pasture yields of Rhodes grass.

2.9.4 Fertilization:

Walton, (1983) indicted that fertilizers are normally used to increase forage yield and quality but since plant tissue reflects the mineral constituents of the soil in which the plants are grown, quality is also greatly influenced. The herbage is especially responsive to the calcium, phosphorus, potassium, sulfur, and nitrogen content of the soil. When species are grown in a pure stand, the effect of these minerals on the plant is direct. The uptake of nutrient was also affected by salinity and form of fertilizer applied. (Irshad *et al*, 2002).

2.9.5 Pests and diseases:

Ehrlich *et al*, (2003) reported that Rhodes grass cultivars are not greatly harmed by pests and diseases.

2.9.6 Effect of seed rate:

Seed rate had received much attention with intention to maximize yield. Johanson and Lloyd, (2005) showed that the suitable seed rate for sowing Rhodes grass is 1-2 kg/ha of good seed and increasing the seed rate to 3-5 kg/ha for irrigated pasture. Abuswar, (2005) reported that the recommended seed rate is 4 kg/fed to obtain maximum yield. Also Valenzuela and Smith, (2002) found that suitable seed rate for growing Rhodes grass broadcast is 40 Ib/acre of pure live seed to give good stand and high forage yield. Luca *et al*, (2001) reported that it is necessary to increase the seed rate of Rhodes grass grown on relatively high saline soil to achieve suitable plant population and high yield, because the rate of growth was high in young plant population and then it decreased according to the effect of salinity. Koul, (1997) reported that the lower seed rate of fodder maize (40kg/ha) resulted in taller plants, more leaves per plant compared to other seed rate of 60 and 80 kg/ha. Forage fresh and dry yields were substantially increased under the highest seed rate. Similar result was found by (Abuswar, 1997; and Nour, 2004).

Springer *et al*, (2007) stated that LAI (Leaf Area Index) was affected by plant density as a result of seed rate, when plant density increased LAI for each species increased curvilinearlly, and dry matter yield responded somewhat quadraticlly.

CHAPTER THREE

MATERIAL AND METHODS

3.1 General description of the experimental area:

The study was carried out from January to May 2008. The experiment location was at the Nursery of the Faculty of Agriculture, University of Khartoum, Shambat, Sudan (latitude 15˚.40 N and longitude 32˚.32 E).

The climate of the study area is described as a semi-arid with only three month of rainfall (July, August and September). (Adam, 1996).

3.2 Material:

Four types of plant spices were selected for this study:

1. Alfalfa: (*Medicago sativa L.)*
2. Teff: (*Eragrostis tef)*
3. Siratro: (*Macroptilium atropurpureum*)
4. Rhodes: (*Choris gayana L*)

3.2.1 Preparation of pots:

This study was conducted using a factorial experiment with Randomized Complete Design with three replicates. Eight hundred pots used. A three kg loamy clay soil in ratio of 1:3 were put in each pot. At the top parts of the pots, about 7 cm were left for irrigation water.

3.2.2 Preparation of pelleting material:

Pelleting techniques namely; farm manure, clay and the control, designated as P1, P2, P3, respectivily. A proper amount of clay and farm manure for each treatment was collected. The water was added and gum Arabic to make a thick solution or paste. Seed were then added and mixed with the thick solution. The solution was left to dry on plastic sacks. Thereafter fragmentation took place, in which small balls were made. The pellets were finally air dried. All pellets were then transferred to the sowing.

3.3 Treatment and Design:

The treatments used in the experiment were three water levels, Ir1 every other day, Ir2 every 4 days and Ir3 every 6 days. Four forage crops namely Teffa grass (*Eragrostis tef*), Rhodes grass (*Chloris gayana),* Alfalfa (*Medicago sativa), Siratro (Macroptilium atropureum)* designed as C1, C2, C3 and C4 respectivily. In each pot 15 seeds were sown. The treatments were laid out in a completely randomized design replicated three times. In each pot, 15 seeds were sown for each crop.

3.4 Irrigation:

After sowing, the pots were uniformly irrigated to insure optimum germination and uniform crop establishment. After one month from germination, the treatments for water regime were applied.

3.5 Thinning:

Thinning was carried out by hand after 30 days from sowing date leaving ten seeding in each pot.

3.6 Parameters measures:

The following parameters were measured during the course of the study:

Plant density, plant height, plant fresh and dry weight, number of leaves, and leaf area per plant.

3.7 Plant density/ pot:

Plant density per pot counted for each individual pot. The plant population counts were taken after 37, 51, 65, 79, and 93 days from sowing.

3.8 Plant height (cm):

Five plants were randomly selected from each plot from the center of the middle, plant height was measured for each plant in each pot from base of the plant at soil surface to the tip longer leaf at 37, 51, 65, 79, and 93 days from the sowing. Then the mean height per plant was obtained.

3.9 Leaf area per plant:

The leaf area per plant was determined by using (leaf area meter) using selected five plants. Then the leaf area index was obtained for each pot.

3.10 Leaf number per plants:

Number of leaves was taken from each individual of the selected five plants after 37, 51, 65, 79, and 93 days from sowing for getting the average number of leaves / plant.

3.11 Plant fresh and dry weights (g):

The predetermined plants previously cut from each pot and then weighed immediately to determine the plant fresh weight.

The samples were air dried and dry weights per plant were obtained. This measurement was done after the harvest.

3.12 Statistical analysis:

The data were analyzed as a factorial design by the Standard Analysis Of Variance Techniques (Gomez and Gomez, 1984).Mean separation of treatment was performed by Duncan's Multiple Range Test (DMRT) procedure.

CHAPTER FOUR

RESULTS

4.1 Effect of Treatments on Growth Parameters:-

4.1.1 Plant height (cm)

The effect of irrigation intervals on plant height at different sampling dates are shown in table (1.a). Significant difference between irrigation intervals are detected at 37, 65 and 79 days of sampling where Ir1 (irrigation every 4 days) resulted is the tallest plants. No significant differences were reported at sampling 51 day, however irrigation every 4 days resulted in the tallest plants compared to other irrigation intervals (Ir2 and Ir3). The ranking order for the irrigation interval treatments was that, tallest plants were recorded for Ir1, Ir2 and Ir3 recorded the shortest plants.

Table (1.b) showed the effect of crop species on plant height. Significant differences were reported between the different crop species for plant height at different sampling dates throughout the experimental period. Teff and Rhodes grass were always significantly taller than Siratro and Alfalfa.

Table (1.c) presented the effect of pelleting treatments on plant height. Significant differences on plant height due to seed pelleting were detected throughout the experimental period with the exception of sampling date 51 and 93.

Farmyard manure pelleting resulted in the tallest plants compared to clay pelleting and the control through the experimental period.

The ranking order for the pelleted treatments with respect to plant height was P1 followed by P2 and P3 resulted in the shorted plants. Farmyard manure pelleting increased plant height by 11% over clay pelleting and by 15% over the control.

Table (1.a): The effect of irrigation interval on plant height (cm).

Treatments	Days					Means
	37	51	65	79	93	
Ir1	16.08 a	20.39 a	23.92 a	29.04 a	32.30 a	24.35
Ir2	12.85 b	16.91 ab	21.95 b	25.46 b	30.56 ab	21.55
Ir3	10.92 c	16.03 b	18.93 c	23.31 c	28.71 b	19.58
Pr ≥ F	0.0001	0.0731	0.0001	0.0001	0.009	
C.V	28.50	47.28	19.08	16.38	15.54	

Means followed by the same letter(s) within each column are not significantly different at 0.05 level of probability using the Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other days

Ir2 = irrigation every 4 days

Ir3 = irrigation every 6 days

Table (1.b): Effect of different forage plants on plant height.

Treatments	Days					Means
	37	51	65	79	93	
C1	19.86 a	25.96 a	29.92 a	34.17 a	38.02 a	29.59
C2	14.46 b	20.42 b	23.06 b	27.73 b	33.42 b	23.82
C3	12.95 b	15.97 b	18.72 c	22.24 c	25.60 c	19.09
C4	5.88 c	8.76 c	14.71 d	19.60 d	24.92 c	14.77
$P \geq F$	0.0001	0.0001	0.0001	0.0001	0.0001	
C.V	28.50	47.28	19.07	16.38	15.54	

Means followed by the same letter(s) within each column are not significantly different at 0.05 level of probability using the Duncan Multiple Range Test (DMRT).

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (1.c): The effect of three types of pellets on plant height (cm) during 2007/28.

Treatments	Days					Means
	37	51	65	79	93	
P1	15.41 a	18.91 a	23.56 a	28.39 a	31.95 a	23.64
P2	12.48 b	18.28 a	20.76 b	25.11 b	30.13 a	21.35
P3	11.96 b	16.14 a	20.48 b	24.30 b	29.54 a	20.49
Pr ≥ F	0.0004	0.07	0.0034	0.0003	0.09	
C.V	28.50	47.28	19.07	16.38	15.54	

Means followed by the same letter(s) within each column are not significantly different at 0.05 level of probability using the Duncan Multiple Range Test (DMRT).

P1 = Farmyard manure pelleting

P2 = Clay pelleting

P3 = Control

Significant differences were reported for this trait, between irrigation and crop, crop and pelleting after 37, 65, 79 and 93 days from sowing (Tables 2.a to 2.d), and (Tables 3.a to 3.d). The highest interaction value between irrigation and crop treatments for plant height was recorded for C2 Ir2 after 37 days, 56 days, 79 days and after 93 days, whereas the shortest plants were recorded for the interaction C4 Ir1 after 37 days, 79 days, and for C4 Ir2 after 65 days and for C3 Ir3 after 93 days. (Table 2.a to 2.d).

For the irrigation and pelleting treatments interaction the tallest plants were recorded for C2 P2 after 65 days, 79 days and 93 days and for C2 P3 after 65 days, 79 days and 93 days and for C2 P3 after 37 days. On the other hand, the shortest plants were recorded for C4 P1 at 37 days, 56 days and 79 days and for C4 P3 after 93 days. (Table 3.a to 3.d).

4.1.2 Number of leaves/plant:

The effect of irrigation intervals on number of leaves at different sampling dates are shown in Table (4.a). Significant differences between irrigation intervals are detected at 37, 51, 65, 97 and 93 days of sampling. The highest number of leaves obtained in Ir1 (irrigation every 4 days). The ranking order for the irrigation interval treatments for this parameter was Ir1, Ir2 and Ir3.

Significant differences were reported between the different crops in number of leaves at different sampling dates throughout the experimental period. Teff and Rhodes grass were always significantly registered the highest number of leaves/plant than Siratro and Alfalfa. (Table 4.b).

Table (4.c) presented the effect of pelleting treatments on number of leaves. No significant difference on number of leaves due to seed pelleting were recorded through the experimental period. However the trend was that farmyard manure pelleting resulted in the highest number of leaves compared to clay pelleting and the control through the experimental period.

Table (2.a). Forage crop*irrigation intervals Interaction for plant height after 37 day.

Crop species	Irrigation treatment		
	Ir1	Ir2	Ir3
C1	9.96 cd	16.02 b	17.40 b
C2	17.58 b	24.22 a	17.78 b
C3	10.44 c	18.51 b	9.89 cd
C4	5.71 e	5.58 e	6.33 de

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4days

Ir3 = irrigation every 6 days

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (2.b). Forage crop*irrigation intervals interaction for plant height after 65 day.

Crop species	Irrigation treatment		
	Ir1	Ir2	Ir3
C1	19.54 c	25.11 b	24.51 b
C2	28.44 b	33.49 a	27.84 b
C3	15.11 d	24.89 b	16.16 cd
C4	12.60 d	12.22 d	19.30 c

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4days

Ir3 = irrigation every 6 days

C1 =Teff grass

C2 = Rhodes grass

C3 = Alfalfa grass

C4 = Siratro

Table (2.c). Forage crop*irrigation intervals interaction for plant height after 79 day.

Crop species	Irrigation treatment		
	Ir1	Ir2	Ir3
C1	24.73 d	30.16 c	28.311 cd
C2	34.71 ab	37.62 a	30.19 c
C3	17.20 e	31.21 bc	18.31 e
C4	16.59 e	17.16 e	25.04 d

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4days

Ir3 = irrigation every 6 days

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (2.d). Forage crop*irrigation intervals interaction for plant height after 93 day.

Crop species	Irrigation treatment		
	Ir1	Ir2	Ir3
C1	30.48 d	33.80 cd	35.97 bc
C2	39.38 ab	40.96 a	33.72 cd
C3	22.87 e	33.34 cd	20.49 e
C4	21.28 e	21.97 e	32.07 cd

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4days

Ir3 = irrigation every 6 days

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (3.a). Interaction between irrigations intervals and seed pelleting techniques on plant height after 37 day.

Crop species	Pelleting treatment		
	P1	P2	P3
C1	13.49 bc	10.38 c	19.51 a
C2	19.71 a	19.76 a	20.11 a
C3	11.59 bc	12.0 bc	15.26 b
C4	5.14 d	5.71 d	6.78 d

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

P1 = Farmyard manure pelleting

P2 = Clay pelleting

P3 = Control

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (3.b). Interaction between irrigations intervals and seed pelleting techniques on plant height after 65 day.

Crop species	Pelleting treatment		
	P1	P2	P3
C1	22.53 b	16.93 cd	29.70 a
C2	29.38 a	31.31 a	27.59 a
C3	17.89 cd	17.93 cd	20.33 bc
C4	12.11 e	16.86 cd	15.16 de

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

P1 = Farmyard manure pelleting

P2 = Clay pelleting

P3 = Control

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (3.c) .Interaction between irrigations intervals and seed techniques pelleting on plant height after 79 day.

Crop species	Pelleting treatment		
	P1	P2	P3
C1	26.91 b	20.82 cd	35.47 a
C2	32.38 a	35.59 a	34.56 a
C3	21.02 cd	23.97 bc	16.92 d
C4	16.92 d	22.31 c	19.56 cd

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

P1 = Farmyard manure pelleting

P2 = Clay pelleting

P3 = Control

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (3.d).Interaction between irrigations intervals and seed pelleting on plant height after 93 day.

Crop species	Pelleting treatment		
	P1	P2	P3
C1	31.14 b	27.94 bcd	41.16 a
C2	38.22 a	38.22 a	37.71 a
C3	25.30 cde	25.21 cde	26.28 cde
C4	23.58 de	29.0 bc	22.64 e

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

P1 = Farmyard manure pelleting

P2 = Clay pelleting

P3 = Control

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (4.a): The effect of irrigation interval on number of leaves per plant.

Treatments	Days					Means
	37	51	65	79	93	
Ir1	20.41 a	28.63 a	38.59 a	43.52 a	44.93 a	35.22
Ir2	16.09 b	16.21 b	26.93 b	31.66 b	35.55 b	25.29
Ir3	10.97 c	16.21 b	22.91 b	30.41 b	34.14 b	22.93
Pr ≥ F	0.0002	0.0001	0.0001	0.0004	0.0031	
C.V	56.77	42.82	49.83	42.04	36.85	

Means followed by the same letter(s) within each column are not significantly different at 0.05 level of probability using the Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4 days

Ir3 = irrigation every 6 days

Table (4.b): Effect of crops on number of leaves per plant.

Treatments	Days					Means
	37	51	65	79	93	
C1	22.67 a	29.37 a	39.01 a	45.17 a	25.96 a	32.44
C2	20.93 a	28.26 a	35.51 a	41.08 a	20.42 b	29.24
C3	10.05 b	14.63 b	22.96 b	27.62 b	15.97 b	21.44
C4	9.64 b	9.13 c	20.42 b	26.92 b	8.76 c	14.97
P ≥ F	0.0001	0.0001	0.0001	0.0001	0.0003	
C.V	56.77	42.82	49.83	42.04	36.85	

Means followed by the same letter(s) within each column are not significantly different at 0.05 level of probability using the Duncan Multiple Range Test (DMRT).

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (4.c): The effect of three types of pellets on number of leaves per plants.

Treatments	Days					Means
	37	51	65	79	93	
P1	17.36 a	21.13 a	30.80 a	37.71 a	18.91 a	25.18
P2	16.61 a	20.74 a	30.13 a	35.07 a	18.28 a	24.17
P3	13.51 a	19.17 a	27.49 a	32.82 a	16.14 a	21.83
Pr ≥ F	0.16	0.60	0.60	0.379	0.185	
C.V	56.77	42.82	49.83	42.04	36.85	

Means followed by the same letter(s) within each column are not significantly different at 0.05 level of probability using the Duncan Multiple Range Test (DMRT).

P1 = Farmyard manure pelleting

P2 = Clay pelleting

P3 = Control

(Tables 5.a to 5.e) show that the interaction between irrigation and crop at 37, 51, 65, 79 and 93 days from sowing was significant for number of leaves/plant.

The highest number of leaves per plant was recorded for C3 Ir2 at 51, 65 and 79 days from sowing and for C2 Ir2 only after 37 days for sowing. The lowest number of leaves per plant, on the other hand, was recorded for C1 Ir1 after 37, and 51 days from sowing, for C4 Ir2 at 65 days and for C1 Ir2 after 79 days (Table 5.a to 5.d). After 93 days C3 Ir2 resulted in the highest number of plants, whereas C3 Ir4 resulted in the lowest number of leaves per plant (Table 5.e).

4.1.3 Plant density (plants/pot):

Significant differences on plant density between irrigation intervals are detected at 37, 51, 65, 97 and 93 days of sampling. The irrigation every other day scored the highest plant density per pot in all sampling dates, whereas irrigation every 6 days resulted in the lowest number of plant density per pot (Table 6.a).

Table (6.b) showed the effect of crop treatments on number of plant density per pot. Significant differences were reported between the different crops throughout the experimental period. Teff and Rhodes grass were always significantly higher in number of plants than Alfalfa and Siratro.

No significant difference on number of plants due to seed pelleting were recorded throughout the experimental period. Farmyard manure pelleting resulted in the highest plant density per pot compared to clay pelleting and control through the experimental period. Farmyard pelleting increased plant density per pot by 6% over clay pelleting and by 13% over the control (Table 6.c).

Table (5.a). Interaction between irrigations intervals and crops on number of leaves per plant after 37 day.

Crop species	Irrigation treatment		
	Ir1	Ir2	Ir3
C1	4.05 d	4.69 d	21.42 b
C2	17.16 bc	34.58 a	16.29 bc
C3	13.60 bcd	33.73 a	15.47 bc
C4	9.08 cd	8.65 cd	11.20 cd

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4days

Ir3 = irrigation every 6 days

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (5.b). Interaction between irrigations intervals and crops on number of leaves per plant after 51 day.

Crop species	Irrigation treatment		
	Ir1	Ir2	Ir3
C1	7.97 d	11.47 cd	7.97 d
C2	21.91 b	44.29 a	21.91 b
C3	19.10 bc	46.57 a	19.10 bc
C4	15.86 bcd	12.19 cd	15.86 bcd

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4days

Ir3 = irrigation every 6 days

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (5.c).Interaction between irrigations intervals and crops on number of leaves per plant after 65 day.

Crop species	Irrigation treatment		
	Ir1	Ir2	Ir3
C1	19.23 cd	14.73 b	34.91 c
C2	26.56 cd	53.47 b	26.50 cd
C3	24.76 cd	69.98 a	22.30 cd
C4	21.09 cd	16.17d	23.99 cd

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4days

Ir3 = irrigation every 6 days

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa grass

C4 = Siratro

Table (5.d). Interaction between irrigations intervals and crops on number of leaves per plant after 79 day.

Crop species	Irrigation treatment		
	Ir1	Ir2	Ir3
C1	25.58 cd	19.71 d	37.56 c
C2	34.0 cd	58.30 b	30.94 cd
C3	30.68 cd	75.26 a	29.02 cd
C4	31.38 cd	20.26 d	29.12 cd

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4days

Ir3 = irrigation every 6 days

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (5.e).Interaction between irrigations intervals and crops on number of leaves per plant after 93 day.

Crop species	Irrigation treatment		
	Ir1	Ir2	Ir3
C1	26.06 cd	25.20 cd	47.16 b
C2	39.44 bc	64.13 a	37.23 bc
C3	37.57 bc	65.07 a	21.67 d
C4	33.51 bcd	25.33 cd	36.13 bcd

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4days

Ir3 = irrigation every 6 days

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (6.a): The effect of irrigation interval on plants density (plant/pot).

Treatments	Days					Means
	37	51	65	79	93	
Ir1	9.61 a	9.72 a	9.75 a	9.81 a	9.83 a	9.74
Ir2	9.44 a	9.58 a	9.33 a	9.56 a	9.56 a	9.49
Ir3	8.00 b	8.00 b	8.00 b	8.00 b	8.00 b	8
Pr ≥ F	0.0004	0.001	0.004	0.0006	0.0005	
C.V	24.24	23.85	24.86	23.97632	22.33	

Means followed by the same letter(s) within each column are not significantly different at 0.05 level of probability using the Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4 days

Ir3 = irrigation every 6 days

Table (6.b): Effect of crops on plant density (plant/pot).

Treatments	Days					Means
	37	51	65	79	93	
C1	9.63 a	9.78 a	9.78 a	9.78 a	9.78 a	9.75
C2	9.48 ab	9.48 ab	9.48 a	9.48 ab	9.48 a	9.48
C3	8.63 ab	8.70 ab	8.74 ab	8.6296 ab	8.70 ab	8.70
C4	8.33 b	8.44 b	8.15 b	8.48 b	8.52 b	8.38
P ≥ F	0.09	0.06	0.04	0.08	0.083	
C.V	24.24	22.85	24.86	22.48	22.33	

Means followed by the same letter(s) within each column are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (6.c): The effect of three types of pellets on plant density (plant/pot).

Treatments	Days					Means
	37	51	65	79	93	
P1	9.23 a	9.28 a	9.28 a	9.28 a	9.31 a	9.28
P2	9.19 a	9.28 a	9.03 a	9.28 a	9.28 a	9.21
P3	8.59 a	8.75 a	8.78 a	8.81 a	8.81 a	8.75
Pr ≥ F	0.34	0.57	0.06	0.53	0.51	
C.V	24.24	22.85	24.86	22.48	22.33	

Means followed by the same letter(s) within each column are not significantly different at 0.05 level of probability using the Duncan Multiple Range Test (DMRT).

P1 = Farmyard manure pelleting

P2 = Clay pelleting

P3 = Control

Irrigation by crop and crop by pelleting interaction were significant for plant densityper pot after 37 days.

(Tables 7.a and 7.b) show that the interaction between pelleting and crop at 37 and 51 days from sowing. It was significant for plant density per pot. The highest interaction values of plant density per pot were observed by C2 P2 for 37 days and by C2 P3 for 51 days whereas the lowest plant density per pot were recorded for C4 P1 at 37 and 51days after sowing.

4.1.4 Leaf area per plant:

Table (8) shows the effect of irrigation intervals, crop and pellets treatments on leaf area per plant at harvesting.

Significant differences were detected between irrigation intervals and crop treatments but the effect of pelleting was not significant. Irrigation every other day registered the highest leaf area per plant than Siratro and Alfalfa. Table (9) shows that the interaction between irrigation and crop on leaf area index at harvesting. The C1 Ir2 recorded the highest leaf area per plant, whereas C3 Ir1 recorded the lowest ratio.

4.2 Effect of treatments on yield:

4.2.1 Fresh weight:

Significant differences among irrigation intervals (Ir1, Ir2, and Ir3) and crop treatments (C1, C2, C3 and C4) were obtained for this character at harvesting (Table 10). Fresh weight (g/plant) ranged from 24.92 to 17.03, in irrigation interval levels, whereas in crop treatments it extended from 28.92 to 7.33 g/plant.

Table (11) shows that the interaction between irrigation and crop treatments on fresh weight. The highest fresh yield was recorded for C1 Ir3, whereas the lowest yield was recorded for C3 Ir3.

Table (7.a). Interaction between pelleting and crops plant density (plants/pot) after 37 day.

Crop species	Pelleting treatments		
	P1	P2	P3
C1	9.96 cd	16.02 b	17.40 b
C2	17.58 b	24.22 a	17.78 b
C3	10.44 c	18.51 b	9.89 cd
C4	5.71 e	5.58 e	6.33 de

Means followed by the same letters within each column are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

P1 = Farmyard manure pelleting

P2 = Clay pelleting

P3 = Control

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (7.b). Interaction between crop and pelleting on plant density (plant/pot) after 51 day.

Crop species	Pelleting treatment		
	P1	P2	P3
C1	13.49 bc	10.38 c	19.51 a
C2	19.71 a	19.76 a	20.11 a
C3	11.59 bc	12.0 bc	15.26 b
C4	5.14 d	5.71 d	6.78 d

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

P1 = Farmyard manure pelleting

P2 = Clay pelleting

P3 = Control

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (8). The effect of irrigation intervals on leaf area per plant.

Treatments	Irrigation			Crops				Pellets		
	Ir1	Ir2	Ir3	C1	C2	C3	C4	P1	P2	P3
Means	4.01 a	3.74 b	3.73 b	8.34 a	3.43 b	3.27 b	0.25 c	3.91 a	3.83 a	3.74 a
Pr ≥ F	0.0031			0.0001				0.19		
C.V	10.25			10.25				10.25		

Means followed by the same letter(s) within each column are not significantly different at 0.05 level of probability using the Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4 days

Ir3 = irrigation every 6 days

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

P1 = Farmyard manure pelleting

P2 = Clay pelleting

P3 = Control

Table (9): Interaction between irrigations intervals and crops on leaf area per plant at harvesting.

Crop species	Irrigation treatment		
	Ir1	Ir2	Ir3
C1	8.28 a	8.43 a	8.32 a
C2	3.40 bc	3.40 bc	3.50 bc
C3	0.25 c	0.24 c	0.26 c
C4	3.01 bc	2.83 bc	3.98 b

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4days

Ir3 = irrigation every 6 days

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

Table (10). The effect of irrigation intervals on fresh weight/plant (gm).

Treatments	Irrigation			Crops				Pellets		
	Ir1	Ir2	Ir3	C1	C2	C3	C4	P1	P2	P3
Means	24.91 a	20.94 b	17.03 c	28.93 a	27.85 a	19.74 b	7.33 c	22.67 a	21.03 a	19.19 a
Pr ≥ F	0.0001			0.0001				0.13		
C.V	34.53			34.53				34.53		

Means followed by the same letter(s) within each column are not significantly different at 0.05 level of probability using the Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4 days

Ir3 = irrigation every 6 days

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

P1 = Farmyard manure pelleting

P2 = Clay pelleting

P3 = Control

Table (11). Interaction between irrigations intervals and crops for Fresh weight at harvesting.

Crop species	Irrigation treatment		
	Ir1	Ir2	Ir3
C1	24.56 ab	26.44 ab	35.78 a
C2	24.44 ab	27.11 ab	32.0 a
C3	5.22 d	11.89 cd	4.89 d
C4	13.89 c	18.33 b	27.0 ab

Means followed by the same letter(s) are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4days

Ir3 = irrigation every 6 days

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa grass

C4 = Siratro

Farmyard manure increased fresh yield g/plant by 7% and 18%compared to clay pelleting and the control, respectively.

4.2.2 Dry weight g/plant:

Table (12) illustrates the effect of irrigation intervals, crop treatments and pelletting on dry weight at harvesting. Significant differences between irrigation intervals and crop treatments were noticed. Irrigation every other day exhibited the highest dry matter value (13.06 g/plant), where irrigation every 6 days scored the lowest one (10.08 g/plant) for dry weight.

The dry weight g/plant of Teff and Rhodes grass were significantly higher than that of Siratro and Alfalfa.

Pelletting by farmyard manure exceeded clay pelleting and the control by 6% and 14% respectively, on dry yield (g/plant) basis, but the difference was not significant.

Table (12): The effect of irrigation intervals on dry weight/plant (gm).

Treatments	Irrigation			Crops				Pellets		
	Ir1	Ir2	Ir3	C1	C2	C3	C4	P1	P2	P3
Means	13.06 a	12.92 a	10.08 b	19.67 a	19.04 a	6.26 b	3.11 c	12.56 a	12.47 a	11.03 a
Pr ≥ F	0.043			0.0001				0.43		
C.V	46.13			46.13				46.13		

Means followed by the same letter(s) within each column are not significantly different at 0.05 level probability using Duncan Multiple Range Test (DMRT).

Ir1 = irrigation every other day

Ir2 = irrigation every 4 days

Ir3 = irrigation every 6 days

C1 = Teff grass

C2 = Rhodes grass

C3 = Alfalfa

C4 = Siratro

P1 = Farmyard manure pelleting

P2 = Clay pelleting

P3 = Control

CHAPTER FIVE
DISCUSSION

5.1 Growth attributes:

The growth attributes of Rhodes grass, Teff grass, Alfalfa and Siratro which were studied in this work included number of plants per unit area, plant height, number of leaves per plant, Leaf Area Index, plant fresh and dry weights.

5.2 Plant height:

The result showed that shorting irrigation interval increased the plant height. This supports the result of Unger (1982) who noticed shortening irrigation interval increased plant height. In the day 51 recorded was not significant maybe due to cold weather at that period that caused shortage in cell division and elongation. Similar results were reported by Bokhary (1985) in *Sorghum bicolor* and Clitoria who found that the increase in plant height, L.A.I, plant dry weight, fresh matter yield and generally vigorous growth was observed during the first season compared to those obtained during the second season (Winter 1988) due to the environmental conditions which vary to some extend for summer and winter seasons (Appendix 1). Also this may be attributed to water stress. This is in agreement with Slatyer (1969) who found that water stress reduced vegetative development by reducing photosynthesis.

Similar results were reported by Idris (1999) who found that short interval irrigation gave higher value of plant height than the long interval on snap bean (*Phaseolus vulgaris L*). Teff and Rhodes grass were always significant by taller than Siratro and Alfalfa. This is due to the differences in growth habits between legumes and grasses.

The effect of irrigation interval on crop species was significant.This result is in line with the finding of Saeed (1984) and Mansour (1981) for fodder sorghum and Lucerne, respectively. They found that the plant height was significantly increased with decreased irrigation interval. Similarly, Mohamed Ahmed, (1988) working on wheat and El Nadi, (1980) on broad beans, indicated that irrigation at short days increased plant height as compared with longer interval.

The effect of irrigation interval on the pelleting technique was significantly different, but on the day 51 and 93 indicated that there was no significant difference. This is may be an indication that pelleting had no effect on the germination due to temperature variation (Appendix 1). On the days 37, 65 and 79 might be affected by variation of temperature degree in that period.

5.3 Number of leaves / plant:

The effect of irrigation intervals on number of leaves/plant was significant. This result agreed with Idris (1999) who reported that shorter interval irrigation increase the leaf number per plant than the longer interval. On the other hand Elamin (1998) found that increase in number of leaves seem to be associated with increase in plant height and number of branches. Bokhary (1985) found the number of leaves per plant was not significantly affected by water stress. Similar results were reported by Sionit and Kramar, (1977), Pandy *et al* (1984) and Hassan (1987). This may be due to the water stress.

The significant difference among crops species denotes that the difference in number of leaves /plant between them might be due to genetic differences between grasses and legumes.

Farmyard manure pelleting resulted in the tallest plants compared to clay pelleting and the control throughout the experimental period. That may attributed to increased of moisture content pelleted treatment compared to others.

The highest interaction values between irrigation and crop of plant height scored by Teff grass through every other day of irrigation that maybe due to increase the amount of moisture in the soil.

5.4 Plant density per pot:

The effect of pelleting on number of plants showed that in the day 37 there was a significant difference between the pelleting techniques. This may be attributed to the increased photosynthesis and hydrolytic process in this period, but in the day 51, 65, 79, and 93 there was no significant. Pelleting beside conserve moisture around roots, it also contributes by nitrogen found in manure. This finding is in accordance with the result reported by Shama *et al* (1969) who stated that nitrogen rates did not influence the number of plant.

5.5 Leaf Area per plant:

Leaf area was found to increase under short interval irrigation. Similar result was reported by Bokhary (1985) who found that Leaf area index was increased under more frequent irrigation. This is consistent with the finding of Ishag (1982), Mansour (1981). These reductions of L.A.I by water regime can be attributed to the water stress in longer irrigation intervals. Another explanation for this behavior might be the adverse effects of water stress on cell division and cell elongation, as was stated by Kramer (1983). The short plants were observed in pots irrigated every 15 days, while the tallest plants were those irrigated every 7 days. This result is in line to the result of Yasin (1998) who used irrigation intervals on Sennamaka (*Cassia acutifolia* L), 7days hat increased the leaf yield significantly than short period of irrigations are better than the long ones.

There were no significant differences between the three types of pelleting, farmyard manure pelleting resulted in the tallest plants compared to clay pelleting and control throughout the experimental period. That may attributed to increased of moisture content in manure pellets when compared to other treatments.

5.6 Fresh and dry weight:

Irrigation intervals on fresh and dry weights showed that there was a significant difference between the irrigation intervals, also significant difference between the crops species.This result is in line with Saeed (1984) for sorghum, and Hassan (1987) for soybean.`

However Sionit and Kramar, (1977) found that the dry weights in soybean cultivar Ranson were not reduced by water stress applied at any stage of growth, whereas significant reduction was observed in Bragg cultivar due to water stress. Yasin (1998) found that shorter interval days of irrigation increased fresh and dry weights than taller day’s intervals. On the other hand, Slatyer (1969) found that water stress reduced vegetative development by reducing photosynthesis.

There was no significant difference between three types of pelleting P1, P2, and P3. Farmyard manure pelleting resulted the highest yield compared to clay pelleting and the control throughout the experimental period. That may attributed to increased of moisture content in manure pellets compared to others.

SUMMARY AND CONCLUSION

This study aimed to evaluate the effect of different levels of irrigation and three types of pelleting on some species of forages namely Alfalfa *(Medicago sativa L.)*, Teff grass **(***Eragrostis tef***),** Rhodes grass **(***Choris gayana L***.),** and Siratro *(Macroptilium atropurpureum)*.

The results of this experiment can be summarized as follows:-

- Irrigation intervals in Ir1 (irrigation every other day) recorded the highest values at all sampling dates and increased vegetative growth followed, by Ir2 (irrigation every 4 days) and Ir3 (irrigation every 6 days) in all parameters (plant density per pot, plant height, number of leaves per plant, leaves area per plant, plant fresh and dry weights).
- The effect of irrigation intervals on plant height was significant at all levels Ir1, Ir2, and Ir3 along all days 37, 65, 97 and 93 except the irrigation of the day 51. The irrigation interval increased the plant height.
- The effect of irrigation interval on crop species C1, C2, C3 and C4 was significant in the days 37, 51, 65, 79 and 93 through all parameters. Teff and Rhodes grass were always having significant by higher values than Siratro and Alfalfa.
- The effect irrigation interval on the pelleting P1, P2 and P3 on the day 37, 65 and 79 was not significant through all parameters except on plant height on the days 37, 65 and 79. Through all parameters P1 (Farmyard pelleting), recorded the highest values followed by P2 (clay pelleting), then P3 (control).
- The effect of irrigation intervals on number of leaves was significantly different between the means of the treatment Ir1, Ir2 and Ir3 respectively in irrigation day 37, 51, 65, 79 and 93.

- The effect of irrigation interval on number of leaves was significant difference between the means of the treatment Ir1, Ir2 and Ir3 respectively in irrigation day 37, 51, 65, 79 and 93.
- The effect of irrigation interval on leaf area per plant showed that there were significant differences between the irrigation intervals Ir1, Ir2 and Ir3.
- The interaction between irrigation and crop through all parameters except dry weight, Teff grass recorded the highest values of interaction every other day of irrigation also the interaction between crops and pelleting received the highest values by Teff with farmyard manure every other day of irrigation on plant height and number of plants.

Conclusion:-

Based on the findings and results of this study, the following conclusions can be drawn:-

- Shortening the irrigation interval improved growth parameters and increased both fresh and dry yields.
- Farmyard manure pelleting performed better the clay pelleting and the control in growth attributed and yield (fresh and dry).
- Variations in growth and yield between the grass and legume pastures due to the different treatments used.

Prospects and recommendation

- Seed pelleting have proven to be excellent technique to be used for improvement of germination rate and the establishment of the grass seedling.
- Further experiments under arid-semi arid condition are needed and important for preventing wind and water erosions and tolerance to drought to rehabilitate degraded areas.

References

Abu-Shakra, S., M.L.Bhatti and H. Admed. (1977). Effect of forage harvest frequency on subsequent alfalfa seed production and pollen quality. Crop Sci. 16: 428 – 431.

Abu-Suwar, A.O.M (1997). Effect of Seeding rates, sowing methods and fertilizer application on growth and yield of Sorghum (Sorghum bicolor L.) Grown on saline sodic soil. University of Khartoum Journal of Agricultural Sciences, 2 (1): 28-45.

Abu-Suwar, A.O.M (2005). Forage production in the Sudan. University of Khartoum Printing Press. (In Arabic), Pp 45-54.

Abu-Swar, A.O. and A.S. Mohamed. (1997). Effect of Phosphorous application and Rhizobium inoculation on two cultivars of alfalfa: 1- plant density and seed production. University of Khartoum Journal of Agricultural Science 5(1):1-11.

Abu-Suwar, A. O (2007). Range Management, University of Khartoum printing press 32-33.

Agabawi, K.A. (1968). Performance of some Lucerne varieties under Shambat conditions. Sudan Agric. J. 3(1): 90 – 98.

Ahlgren, G.H. (1956). Forage Crop. McGRAW HILL BookCOMPANY, INC. New York, Toronto, London.

Ahlgren, G.H. (1956.) Forage Crops. Mc GRAW HILL Book COMPANY, INC. New York, Toronto, London.

Al-Noaim, A. and Fanorth, J. (1973). Observation on the growth of one year of Hassawi alfalfa grown under irrigation in Saudi Arabia, Univ. College North Wales and Min. Agri and water Saudi Arabia. Joint Agr. Res. And Development Project. Publl. No. 16.

Atkins, E.L. (1983). Producing honeybees in seed alfalfa fields, an update. In: Proc . Alfalfa seed production Symposium, p. 2 - 4. Fresno, C.A University of California Coop. Ext. Service.

Bacon. O.G.(1980). Control integrado de las plagas en semillerose de alfalfa. In Actas simposio de production de semilla de alfalfa, Nov. 6 – 16, 1978. FAO/INTA, Mendoza and Bahia Blanca, Argntina.IDDA 391-392 : 34-44.

Bokhary, A. K. (1985). Effects of irrigation intervals, Clitoria and seasonsl variation on growth and yield of sorghum bicolor (VAR. ABU 70). M.Sc. Thesis, Faculty of Agriculture, University of Khartoum, Sudan.

Bolton, J.L. (1962). Alfalfa Botany, Cultivation and Utilization. New York, Interscience. 474 pp.

Boulton, P. and Norton, B. W.,(1982).Grazing management studies with Australian cashmere goats. 1. Effect of stocking rate on the growth and fleece production of weaner goats grazing tropical pastures Anim. Prod. J. Australia, 14:641.

Burgesser, F.W. (1949). Important developments in coated seeds may save time and money. The Fruit and Vegetable Review 11: 18-19.

Cohen, Y.H Bieloria and A. Dovart. (1972). Effect of timing of irrigation on total nonstructural carpohydrate level in roots and on seed yield of alfalfa (*Medicago sativa L.*) Crop Sci. 12:634 – 636.

Coombe, J. B.,(1981). Utilization of Low-Quality Residues. In Grazing Animals
(Ed. F. W. H. Morley), pp. 319–332, Elsevier, Amsterdam.

Creek, M. J., Barker, J. J. and Hargus, W. A., (1984). Small ruminant production in the developing countries. World Anim. Rev., 15: 12-14.

Darag and Gad El-Kareem (1994). The Development of Seed Pellets For Revegetating Rangeland in Sudan Soils. In (Girigikh) - North Bara. UNDP – Project.

Demiruren, A., (1982). Small ruminant production in the developing countries. In Sheep and Goat Production (Ed. I. E. Coop), pp. 425–440, Elsevier, Amsterdam.

Dolberg, F., Saadullah, M., Haque, M. and Ahmed, R., (1981). prospects for developing small ruminant production in humid tropical Asia. World Anim. Rev., 38: 37–41.

Draz 0. 1978. Revival of the Hema system of range reserves as a basis for the Syrian Range Development Program. In: Hyder D N (eds), Proceedings of the First International Rangeland Congress. Society for Range Management, Denver, Colorado, USA. pp. 100-103.

El Gharbaoui, (1984).Small ruminant production in the developing countries. Proc. 2nd Int. Rangeland Congr., Adelaide. World Anim. Rev. 51: 2–11

Elamin, S. H. (1998) Effect of water regimes and mineral fertilization on production and quality of Cassia acutifolia and Cassia italica. M.Sc. Thesis Faculty of Agriculture, University of Khartoum, Sudan.

El Nadi, A. H. (1980) ICARDA / IFAD/ Nile valley project for Faba beans. Shambat site. ICARDA, Syeria.

Gamar El-Din, (1984). Effect of chicken manure and urea fertilizer on growth and yield of Teff grass (Eragrostis teff. Zucc.). M.Sc. Thesis, University of Khartoum, Sudan.

Gomez, K. A. and A.A Gomez (1984). Randamized Complete Block Design. In : Statistical Procedures for Agricultural Research. John Willey and Sons. New York.

Gurley, G. (1970). Recent Developments in Seed Technology. More and bigger spools ahead. The Packer Jan. 10, 1970, pp.8-9.

Harrington, G.N. 1982. Grazing behaviour of the goat. Proceedings of 3rd International Conference on Goat Production and Disease. Arizona U.S.A. 398–403.

Hassan, W. (1984). Status of Pasture Research and Development . Proc. of the Second International Rangeland Congress, Adelaide, 131p.

Hassan, A. K. (1987). Effect of water stress and inoculation on Soybean (*Glycine max L.*) at two seasons, winter – summer. M.Sc. Thesis, Khartoum University, Sudan.

Herbel, C. A., (1984). Small ruminant production in the developing countries. In Developing Strategies for Rangeland Management. pp. 1167–1178, NRC/Nat. Acad. Sci., Westview Press.

Hollwell, E.D. (1992). Legume and grass seed production. PP.101 – 112. In: Forages (Ed. Health and D.S. Metcalfe) lowa State Collage Press. Ames/lowa, XII + 707 pp, Illustr.

Hughes, H.D., Health, M.E. and Metcalfe, D.S. (1962). Forages, 2 nd. The lowa state University Press, Ames/lowa, U.S.A.

Idris, R. G. (1999). Effect of irrigation and picking interval on growth and yield of snap bean (Phseolus vulgaris L) M.Sc Thesis, Faculty of Agriculture, University of Khartoum, Sudan.

Ishag, H . W. (1982). The influence of irrigation frequency on groundnuts (Arachis hypogea L.) under arid condition J. Agric. Sci. Cawb. 99: 305 – 310.

Jahnke, H. E., (1982). Small ruminant production in the developing countries Livestock Production Systems and Livestock Development in Tropical Africa. Kieler Wissenschaftsverlag Vauk, Kiel.websitewww.taa.org.uk/TAAScotland/LivestockasfoodforpastoralistsinAfrica2001.htm.

Jain, H.K. (1983). Samll ruminant prodection in the developing canteries. Proc. XIV. Int. Grassl. Congr. P. 440. and R. G. Gunn. pp 151-184.

Koul, B.G. (1997). Effect of sowing methods, nitrogen level and seed rates on yield and quality of fooder maize (*Zea maze L.*). M.Sc.Thesis. Faculty of agriculture, University of Khartoum.

Leslie, S. Cobley. (1963). An Introduction to the Botany of Tropical Crops. Western Printing Services LTD, Bristol. Natar 220, P. 911-912.

Lindsay, J. A.,(1984).Animal production and health paper.Anim. Prod, J. Australia, 15:114–117.

Luna, C; De luca, M.And Taleisnik. E (2002). Physiological causes for decreased productivity under high salinity in Boma, a tetraploid *Choris gayana* cultivar. 11. Oxidative stress. Australian J. of Agriculture Research. 53:663. CSIRO Publishing.

Mackenzie, R.E. and Bolton, J.L (1947). Crop production on irrigated heavy texture saline soil with particular reference to Val marine irrigation projects. Sci. Agric.27: 193 – 219.

Malechek, J. C, (1982). Small ruminant production in the developingcountries.Proc. 3rd Int. Conf. on Goat Prod. and Disease, pp. 404–408.

Mannetje, L. 't., (1982). Nutritioanl Limits to Animal Production from Pastures.(Ed. J. B. Hacker), pp. 67–85. Comm. Agr. Bur.

Mansour, M. A. A. (1981). Water stress from fodder Sorghum and Lucerne measuered by different correlation and calculation methods. M.Sc. Thesis, Khartoum University, Sudan.

Marble, V.L (1972). Optimizing alfalfa production in Calfornia. In Proc. 1972. California Symposium, p .41 – 55. Fresno, CA. Univ. of California Coop. Ext. Service.

Marble, V.L (1980). Manejo del cultivo de alfalfa para produccio'n de Semilla. In Proc. Simposio de Prod. De Semilla de Alfalfa.Noviewbre 6 – 16, 1978. FAO. Rome AGPC: MISC/85.

Massengale, M.A. (1947). Management for alfalfa increased forage production. In proc. 4th California/Arizona Low Desert Alfalfa Symposium. P. 69 – 71. El Centro, CA. University of California Coop. Ext. Service.

Minson, D. J., (1982). Small ruminant production in the developing countries (Ed. F. W. H. Morley), pp. 143–158, Elsevier, Amsterdam.

Mohamed Ahmed, B. A. (1988). Effects of irrigation and fertilization on wheat (Triticum aesttivum) grown on salt affected soils. M.Sc. Thesis, University of Khartoum, Sudan.

Salih, M.H. (1987). Green matter yield performance of two Berseem introduction against the local variety. Agric. Res. Coop. Shambat Res. Centre. Annual Report.

Osman, A. E. and Nersoyan, N., (1984). Forage yields and quality of common vetch and oat sown at varying seeding ratios and seeding rates of vetch Proc. 2ndInt Grassl. Congr., Adelaide. (In Press).

Osman, M.S. (1971). The effect of some conditioning methods on the curring of Berseem for hay. Sudan J. Vet. Sci. Anim. Husb., 12, 191, 82 – 89.

Pandy, R. K. W. A. T. Herrara, and J. W. Pendlton. (1984). Drought Response of grain legumes under irrigation gradient 1: Yield components. Agron J. 76 : 549 – 553.

Pedersen, G.R., Bohart, V.L. Marble, and Klostermeyer, F.C. (1972). Seed Production practices. In: C. H. Hassan (ed) Alfalfa Monograph. Am. Soc. Agron., Madison, Wis. USA.

Pedersen, L.G. and McAllister, D.R. (1955). Growing alfalfa for seed. Agric. Exp.Stat. Utah State Agric. Coll. Circ. 135.

Pederson, G.R., Jones, L.G and Rogers, T.H. (1961). Producing seeds of the legumes. In Seed . pp 171 – 181. USDA. Yearbook Agric.

Potts, A. and Hymphreys, L. R. (1983). Effect of Five Species of Earthworm on some Soil Properties.. J. Agr. Sci, 101: 1–7.

Robinson, F.E., and Johnson, H. (1970). Seedling emergence from encapsulated and coated lettuce seed. California Agriculture 24: 10-12.8P9

Saeed, A. M. I. (1984). Comparative methods for estimation of water requriments of fodder Sorghum and Lucerne. M.Sc. Thesis, University of Khartoum, Sudan.

Sharma, M.L. and Uehara, G. (1969). Influence of soil structure on water relation in Low Humic Latosols. 1. Water retention. II. Water movement. SSAP 32(6): 765-774.

Sionit, N. and Kramer, P. J. (1977). Effect of water stress during different stages of growth of Soybean. Agron J. 69: 274 - 258.

Skerman, G.C., and J.P. Gentry. (1988). Lettuce emergence from vermiculite seed tablets containing activated carbon and phosphorus. Hort Science 15: 73-75.

Slatyer, R. O. (1969). Physiological significance of internal water relations to crop Yield in: physiological aspects of crop yield. Richad C. Dinauer (ed) American Society of Agronomy, Madison, Wisconsin USA.

Springer, T.L. And Gillen, R.L.(2007). How does plant population density affect the yield, quality and canopy of native Blue stem (*Andropogon spp*.) forage? Crop Science, A journal series the international community of crop scientist. Volume 47(1):77-82.

Susetyo, S., Whiteman, P. C. and Humphreys, L. R., (1983). Small ruminant production in the developing countries .Proc. XIV Int. Grassl. Cong r., p. 412.

Tysdal, H.M. (1946). Influence of tripping, soil, moisture, plant spacing and lodging on alfalfa seed production. J. Am. Soc. Agron. 40: 293 – 306.

UNESCO/UNEP/FAO, (1979). Tropical Grazing Land Ecosystems - a State of Knowledge Report. UNESCO, Paris. 655 pp.

Unger, P. W. (1982). Time and frequency of irrigation effects on sunflower production and water use. Soil Science Society of America J. 46:5 1072 – 1076.

Valenzuela, H. And Smith, J. (2002). Rhodes grass, sustainable Agriculture, cover crops/SA-CC-3. Cooperative Extension Service, College of Tropical Agriculture and Human Resources. University of Hawai.

Wilson, A. D. (1982). Methods used and results obtained in the transformation of sheep breeding in the people's republic of Bulgaria in sheep and goat production. pp. 309–330 Elsevier, Amsterdam.

Yasin, (1998). Effect of Water Quantities and Itervals of Irrigation on Production and Sennoside Content of Senna makka (*Cassia acutifolia L*.). M.Sc Thesis University of Kkartoum, Sudan.

Young, J. A., Evans, R. A. and Eckert, Jnr. R. E. (1984). Small ruminant production in the developing countries. In Developing Strategies for Rangeland Management, pp. 1259–1300. NRC/Nat. Acad. Sci., West view Press.

APPENDICES

APPENDICES (1)**:** Meteorological data for the experimental period 2008 showing monthly average temperature, relative humidity and rainfall at shambat.

Months	**Temperature C°**		**R.H%**
	Min.	**Max**	
January	14.9	29.9	32%
February	15.9	31.3	31%
March	20.4	38.6	23%
April	25.2	40.4	23%
May	25.7	41.4	18%